Location ID	Average Lead Concentration in Residential Yard (mg/kg)		Lead Concentration in Play Area (mg/kg)		Lead Concentration in Garden (mg/kg)		Lead Conc. in Mat	Lead Conc. in Vacuum Bag	Lead Conc. in Exterior Paint	Lead Conc. in Interior Paint	Water Sample Results exceeding RAL/MCL (µg/L) all first-run
	Surface Soil	Sub-surface	Surface Soil	Sub-surface	Surface Soil	Sub-surface	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
35	364	116	155	71.5	-	-	374	341	15800	-	-
36	766	958	-	-	-	-	2370	882	101000	-	-
37	769	433	-	-	-	-	732	23	-	-	56.1
38	688	346	-	-	-	-	8840	1820	-	-	-
39	16000	17300	-	-	-	-	14000	6150	-	-	-
40	718	536	-	-	-	-	791	2430	-	-	-
41	503	207	-	-	103	96.7	1640	769	19100	-	-
42	500	388	-	-	180	1590	713	387	-	-	-
43	3050	3510	-	-	5480	4770	27800	2730	-	-	-
44	3210	7030	-	-	-	-	59500	-	-	-	-
45	843	849	-	-	-	-	1020	619	-	-	-
46	852	994	-	-	1200	911	2040	3300	10900	47400	-
47	56.2	29.5	-	-	-	-	655	626	4860	-	-
48	319	186	-	-	-	-	468	504	-	-	-
49	256	224	-	-	-	-	368	492	1140	-	-
50	7060	12000	-	-	6605	15020	2420	-	-	-	15.7
51	3030	900	-	-	1240	1170	1060	621	19200	6820	-
52	787	759	-	-	406	895	1600	1550	-	-	-
53	735	739	1120	1530	89.6	80.4	380	315	-	-	-
54	544	213	316	109	85.8	80.7	778	504	679	-	-
55	642	650	-	-	-	-	615	384	-	-	-
56	353	179	-	-	-	-	1120	833	5210	-	-
57	1190	1470	-	-	-	-	1210	-	7600	-	-
58	2710	6970	-	-	-	-	1620	353	10700	-	-
59	1170	786	-	-	-	-	790	778	29900	-	26.9
60	188	182	48.7	15.9	142	133	182	232	-	-	-
61	284	234	-	-	-	-	2050	1680	-	-	-
62	2920	186	-	-	-	-	-	-	-	-	-
63	563	943	-	-	-	-	1370	655	31900	-	-
64	2700	4220	-	-	-	-	4460	1540	15300	-	-
65	1210	1190	516	558	287	292	858	937	4040	-	-
66	1090	1140	-	-	-	-	990	780	2250	1370	39.8
67	2430	2190	-	-	11800	9900	1130	1380	-	-	-
68	479	500	-	-	-	-	604	727	-	-	-
69	1270	663	-	-	-	-	-	-	115000	27400	-
70	1380	984	-	-	-	-	3100	405	1110	-	-
71	346	465	-	-	-	-	1730	942	155000	-	-
72	26.9	-	-	-	-	-	-	292	-	-	-

Location ID	Average Lead Concentration in Residential Yard (mg/kg)		Lead Concentration in Play Area (mg/kg)		Lead Concentration in Garden (mg/kg)		Lead Conc. in Mat	Lead Conc. in Vacuum Bag	Lead Conc. in Exterior Paint	Lead Conc. in Interior Paint	Water Sample Results exceeding RAL/MCL (µg/L) all first-run
	Surface Soil	Sub-surface	Surface Soil	Sub-surface	Surface Soil	Sub-surface	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
73	34	26.8	-	-	-	-	440	53	590	-	-
74	3840	2190	-	-	-	-	1360	362	-	-	-
75	453	958	216	444	365	314	1090	-	-	-	-
76	3290	3440	-	-	-	-	3210	2840	-	-	-
77	2560	2860	995	3250	1120	949	1550	-	1110	2170	-
78	654	249	-	-	-	-	2080	2400	-	-	-
79	510	120	-	-	-	-	-	-	-	-	-
80	748	333	354	281	-	-	1410	1000	142000	-	-

Method I: Calculation of an estimated dose and comparison to the IOC

The following routes of exposure were considered:

Ingestion:

Soil & Dust	Soil and dust ingestion were analyzed quantitatively through calculation of an external dose using average lead concentrations.
Homegrown Foods	Lead levels in garden vegetables were analyzed and their contribution examined quantitatively. However, this data was not incorporated with garden soil lead levels, because sources of the vegetables were not matched with soil sample locations. Future work should include this pathway.
Tap Water	Potable water was included where sampling indicated lead levels exceeded the EPA's action level for lead.

Inhalation:

Air particulates	No sampling data were available, therefore background levels were used.

Dermal:

Soil	This pathway is considered negligible as appreciable levels of lead do not penetrate through the skin (ATSDR, 1999)

External dose for children's soil ingestion was calculated:

$$Dose_{soil} = \frac{C \times IR \times BF \times CF}{BW} = \frac{\text{Conc} \times\ 0.5 \times 200\,\text{mg/day} \times 10^{-6}}{16\text{kg}}$$

where

C = concentration of lead in soil, mg/kg
IR = ingestion rate, mg/day
BF = bioavailability factor
BW = body weight, kg
CF = conversion factor (kg to mg)

Concentrations used were the surface soil composite samples. The ingestion rate of 200 mg/day was used as a conservative mean estimate of children's soil ingestion (EPA, 1999)*. An average

*The typical infant and toddler oral exploratory behaviors include repetitive mouthing which results in continuous ingestion by these children of small amounts of dust and soil over the course of a play period, ultimately adding up to a daily intake of 100 to 200 mg (Mushak 1998).

recommended body weight of 16 kg was used as a mean estimate (EPA, 1999)*. An absolute bioavailability factor of 50% for soil-born lead was used.** This leads to a mean estimate of children's exposed dose, although it needs to be remembered that use of composite surface soil measurements may result in an underestimation of the true concentration, because "hotspots" may not be detected.

External dose for children indoor dust ingestion was calculated:

$$Dose_{dust} = \frac{C \times IR \times BF \times CF}{BW} = \frac{\text{Conc} \times IR \times BF \times 10^{-6}}{16\text{kg}}$$

The ingestion rate for dust was taken from estimates of soil and total soil and dust ingestion from the Exposure Factors Handbook (EPA, 1999). Average dust ingestion as a percentage of total soil and dust ingestion was calculated for mean and high-end estimates. Dust ingestion was separated from soil ingestion in this consultation in order to ascertain the specific contributions of dust lead and soil lead to total exposure. Prior studies have ascertained a high indoor dust contribution to total lead exposures (IDHW, 1999).

Similar methodologies were utilized for the other input routes, with the input variables presented in Table B-1 below.

Table B-1. Input parameters used to quantify mean background air and food lead exposures, and tap water lead exposures when the action level was exceeded.

Route	Lead concentration	Reference	Ingestion/ Inhalation rate	Reference
Tap water	residence-specific	see data, Appendix A	0.58 L/day	EPA, 1999 for children ages 1-4
Air (background only)	0.10 $\mu g/m^3$	EPA, 1994	5 m^3/day	EPA, 1994 median ventilation rate

*16 kg (roughly 35 pounds) is approximately the body weight of a child one to two years of age. The Centers for Disease Control and Prevention (CDC) has said that focus should be on children between the ages of 12 and 36 months (1- and 2-year-old children) because blood lead levels tend to be highest in this age group, and more children in this age group have blood lead levels equal to or greater than 10 μg/dl (CDC, 1997).

**The value of 50% bioavailability was selected as representative of the upper range of values seen in a variety of studies measuring absolute and relative lead bioavailability (Mushak, 1998; Maddaloni, 1998; Henningsen, 1998).

Food	6 µg/day	EPA, 1994, median value	n/a	

L/day = liters per day
µg/m³ = micrograms per cubic meter
m³/day = cubic meters per day
n/a = not applicable

Method 2: Calculation of expected blood lead levels

Surface soil and indoor house dust lead levels were entered into the EPA's IEUBK model (EPA, 1994). Based on the above calculations, soil and dust incidental ingestion were found to have an appreciably greater contribution to total dose than other exposure routes. Therefore, when using the model, other input distributions were left at default values. Only the effect of soil and indoor dust lead levels were examined. In order to keep the IEUBK model consistent with the previous calculations, soil ingestion as a percentage of total soil and dust ingestion was increased from the default value of 45% to 71%. Expected blood lead levels were then recorded as being between an upper and lower range. Expected blood lead level data can be seen in Appendix C. The blood lead upper and lower range values were then averaged to calculate an average blood lead level, and locations were categorized as having an average blood lead level either greater or less than 10 µg/dl. Several residences had average blood lead levels less than 10 µg/dl, but as the blood lead range included 10 µg/dl they were considered to represent an intermediate category.

In the IEUBK model, the Geometric mean blood lead level which corresponds to a probability of 10 μg/dl is approximately 5 μg/dl. This relationship is sensitive to the geometric standard deviation (GSD): default = 1.6.

Method 3: ATSDR's integrated exposure regression analysis

Numerous longitudinal and cross-sectional studies have attempted to correlate environmental lead levels with blood lead levels. These studies have provided a number of regression analyses and corresponding slope factors (δ) for various media including air, soil, dust, water, and food. The ATSDR integrated exposure regression analysis utilizes slope values from select studies to integrate all exposures from various pathways, thus providing a cumulative exposure estimate expressed as total blood lead (ATSDR 1999, Appendix D).

The general form of the model is:

$$PbB = \delta_s TPb_s + \delta_d TPb_d + \delta_w TPb_w + \delta_{ao} TPb_{ao} + \delta_{ai} TPb_{ai} + \delta_f TPb_f$$

where,

Pb_s = soil lead concentration

Pb_d = dust lead concentration
Pb_w = water lead concentration
Pb_{ao} = outside air lead concentration
Pb_{ai} = inside air lead concentration
Pb_f = food lead concentration
T = relative time spent
δ = the respective slope factor for specific media

Table B- 2: Selected Slope Factors for Specific Media (ATSDR 1999, Appendix D)

Media	Population	Slope	Source
Air	Children (1-18 yrs)	1.92 ± 0.60	Angle et al, 1984 as cited in ATSDR 1999, App D
Water	Children	0.16 at <15 μg/L 0.03 at >15 μg/L	Laxen et al, 1987 as cited in ATSDR 1999, App D
Diet	Infants & Toddlers	0.24	Ryu et al, 1983 as cited in ATSDR 1999, App D
Soil	Children (1-72 mo)	0.002 ± 0.00082	Stark et al, 1982 as cited in EPA 1986
Dust	Children (2 yrs old)	0.002 ± 0.00066	Stark et al, 1982 as cited in ATSDR 1999, App D

μg/L = micrograms per liter

Table B-3: Default Values for Missing Data (ATSDR 1999, Appendix D)

Media	Default
Outdoor Air	0.1-0.2 $\mu g/m^3$
Indoor Air	0.03-0.06 $\mu g/m^3$ (0.3 x outdoor conc.)
Food	5 μg/day
Water	4 μg/L
Indoor Dust	947 (ave. Indoor dust conc. for 71 residences sampled)

$\mu g/m^3$ = micrograms per cubic meter
μg/day = micrograms per day
μg/L = micrograms per liter

Bioavailability was not estimated for this method, as each slope factor is based upon observed blood lead levels correlated with environmental concentrations. The average surface soil concentration was used unless a surface soil concentration was available in a "play area", which was then used. For indoor dust, vacuum bag concentrations were used. For those few residences without vacuum bag data, the average vacuum bag concentration of the other 71 residences with data was used.

The example described within Appendix D of the ATSDR Toxicological Profile for Lead selected larger soil/dust slope values plus or minus three standard deviations to determine the high and low range of blood leads. In this health consultation, values more specific to children aged 1- 3 were selected, and only one standard deviation was added or subtracted for determining the low and high range of blood leads. Subtracting three standard deviations from the slope values selected for this health consultation created negative slopes at the low end, therefore, this was not done. The net effect would be to make the method utilized in this health consultation much less conservative than the example outlined in Appendix D of the Toxicological Profile. Based upon the results provided in Table 5, Appendix D of the Toxicological Profile (which showed this method to correlate well with actual blood lead levels), this would result in an underestimation of the number of residences at which the blood lead range could exceed 10 μg/dl. A benefit to be gained by this method, however, is that those residences most likely to be a problem should be highlighted in this health consultation.

Appendix C: Coeur d'Alene River Basin Residential Properties. Estimated dose, the number of time the dose is greater than the IOC, and the expected blood lead ranges by residential location ID.

Location ID	Total Pb dose	Times Dose > IOC	EPA IEUBK BPb Range (µg/dl)		ATSDR Regression BPb Range (µg/dl)	
	mg/kg/day	[-]	Lower	Upper	Lower	Upper
1	0.0054	2.9	5.6	9.9	3.4	5.3
2	0.0061	3.3	6	10.5	3.4	5.4
3	0.0027	1.5	3.7	6.4	3	4.3
4	0.0033	1.8	3.8	6.7	2.6	3.6
5	0.0094	5.1	8.4	14.4	4.4	7.7
6	0.0024	1.3	3.3	5.6	2.6	3.6
7	0.0066	3.6	6.2	10.8	3.2	5.1
8	0.0027	1.5	3.5	6.1	2.7	3.7
9	0.0058	3.1	5.9	10.4	3.6	5.7
10	0.0030	1.6	3.6	6.3	2.7	3.7
11	0.0072	3.9	7.1	12.4	4.3	7.2
12	0.0231	12.5	15	24	6.7	13.3
13	0.0386	20.8	22	33	10.7	22.5
14	0.0074	4.0	7.2	12.5	4.2	7.2
15	0.0239	12.9	15	25	7.3	14.5
16	0.0095	5.1	8.8	15	5	8.9
17	0.0032	1.7	4	7	3	4.4
18	0.0072	3.9	6.5	11.4	3.9	6.4
19	0.0071	3.8	6.7	11.7	3.6	5.9
20	0.0042	2.3	4.7	8.3	3.4	5.3
21	0.0111	6.0	9.6	16.2	5	9.1
22	0.0122	6.6	10	16.9	4.1	7.1
23	0.0078	4.2	7.3	12.6	4	6.7
24	0.0066	3.5	6.4	11.2	3.7	6
25	0.0031	1.7	3.6	6.3	2.5	3.4
26	0.0058	3.2	6	10.5	3.6	5.8
27	0.0047	2.5	5	8.7	3	4.6
28	0.0098	5.3	8.6	14.7	4.3	7.6
29	0.0036	2.0	4.2	7.3	2.9	4.1
30	0.0120	6.5	9.9	16.8	4.9	8.9
31	0.0066	3.6	6.5	11.4	3.7	6
32	0.0246	13.3	16.5	25.8	17.4	38.6
33	0.0027	1.5	3.5	6.1	2.7	3.8
34	0.0110	5.9	9.3	15.9	4.8	8.5
35	0.0031	1.7	3.8	6.6	2.5	3.2
36	0.0066	3.6	6.5	11.4	3.8	6.3

Location ID	Total Pb dose	Times Dose > IOC	EPA IEUBK BPb Range (µg/dl)		ATSDR Regression BPb Range (µg/dl)	
	mg/kg/day	[-]	Lower	Upper	Lower	Upper
37	0.0060	3.3	5	8.9	3.9	5.2
38	0.0078	4.2	7.8	13.4	4.8	8.4
39	0.1114	60.2	42.5	60.9	27.9	62.3
40	0.0091	4.9	8.9	15.1	5.6	10
41	0.0048	2.6	5.2	9.2	3.4	5.3
42	0.0040	2.2	4.5	7.9	2.9	4.3
43	0.0242	13.1	16.9	26.3	8.7	17.3
44	0.0202	10.9	14.1	22.5	74.7	158.6
45	0.0066	3.6	6.4	11.2	3.6	5.9
46	0.0115	6.2	10.7	17.8	6.7	12.5
47	0.0017	0.9	2.8	4.8	2.7	3.7
48	0.0031	1.7	3.9	6.8	2.9	4.1
49	0.0027	1.5	3.5	6.2	2.8	3.9
50	0.0446	24.1	24.1	35.5	12.9	27.7
51	0.0202	10.9	14.3	22.9	6.2	12
52	0.0080	4.3	7.7	13.4	4.6	8
53	0.0054	2.9	5.4	9.5	3.6	5.9
54	0.0045	2.4	4.9	8.6	2.9	4.1
55	0.0049	2.6	5.1	9	3.1	4.7
56	0.0039	2.1	4.6	8.2	3.3	5
57	0.0076	4.1	6.8	11.9	4.3	8.3
58	0.0178	9.6	12.9	21	5.5	10.5
59	0.0094	5.1	8	13.8	4.3	7.3
60	0.0018	1.0	2.7	4.5	2.2	2.7
61	0.0050	2.7	5.9	10.3	4.2	6.9
62	0.0184	10.0	13.2	21.3	5.4	10.4
63	0.0049	2.6	5.2	9.3	3.3	5.2
64	0.0198	10.7	14.5	23	6.9	13.4
65	0.0094	5.1	8.4	14.4	3.6	5.7
66	0.0092	4.9	7.7	13.3	4.6	7.5
67	0.0179	9.7	13.4	21.6	6	12.2
68	0.0045	2.4	5	8.8	2.9	5.1
69	0.0081	4.4	7.1	12.4	3.1	5.7
70	0.0096	5.2	8.2	14.2	3.6	6.8
71	0.0040	2.2	4.8	8.5	3	5.3
72	0.0009	0.5	2	3.2	1.9	2.8
73	0.0005	0.3	1.6	2.2	1.6	2.2
74	0.0248	13.4	16.4	25.6	6.4	13.7
75	0.0031	1.6	3.5	6.1	3	5.3
76	0.0259	14.0	17.7	27.3	8.7	18.3

Location ID	Total Pb dose	Times Dose > IOC	EPA IEUBK BPb Range (µg/dl)		ATSDR Regression BPb Range (µg/dl)	
	mg/kg/day	[-]	Lower	Upper	Lower	Upper
77	0.0162	8.8	11.9	19.6	6.3	13
78	0.0086	4.7	8.6	14.7	5	9.7
79	0.0034	1.8	3.8	6.6	2.2	3.6
80	0.0067	3.6	6.6	11.6	3.5	6.5